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NASA TECH BRIEF
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A Study of Radiation Environment in Space and Its Biological Effects

Based on previous studies[1,2] of radiation environment both within and outside of the earth's magnetosphere, galactic and solar cosmic radiation was investigated, along with its possible biological effects on man in space. Specific areas covered included secondary ion generation, galactic and solar cosmic radiation activity, and evaluation of aluminum shielding to prevent the hazards of radiation.

Results of the study indicate the importance of secondary ions which contribute significantly to galactic cosmic radiation hazards. The rate of production of secondary ions of atomic number j at various points in the absorber by the primary ions of atomic number i is given by

$$\frac{d\phi_j}{dx}(T', x) = \phi_i(T, x)\,\frac{N_O}{M}\,\sigma_i(T)\,P_{ij}(T, T')$$

where

$\phi_i(T, x)$	is the energy spectrum of ions of type i;
$\sigma_i(T)$	is the interaction cross section for ions of type i and energy T;
$P_{ij}(T, T')$	is the fragmentation parameter, giving the probability for an interaction of type i ions at energy T to produce a secondary ion of type j and energy T′;
N_O	is Avogadro's number;
M	is the atomic weight of the absorber; and
$\frac{d\phi_j}{dx}(T', x)$	is the rate at which particles of type j; and energy T′ are being produced in the absorber at point x.

The basic assumption in this expression is that the cross sections are independent of the primary energies in the range of 100 MeV/nucleon to 30 GeV/nucleon. In addition, the maximum atomic number of primary ions is limited to 26, because only a relatively small amount of higher atomic number particles are present in the galactic cosmic ray flux. The principal limitation of this expression still lies in the accuracy of estimating the fragmentation parameters that correspond to the heavy primary ion dose (< 100 MeV/nucleon). However, the present set of fragmentation parameters used does indicate the general characteristics of the depth-dose profiles.

Estimations of the solar cosmic ray hazard are still uncertain. Although the correlation of the sunspot activity with particle activity was accurate for the solar cycle 20 based on the cycle 19 data,[3,4] large variations in probability of encountering rare events remain. While methods exist for predicting the characteristics of future cycles, based on the observed periodicity in the sunspot activity, the most accurate predictions are those which use the early portion of the cycle to determine its behavior.

In the study of radiation shielding for astronauts, aluminum spherical shielding of 1.4 and 10 g/cm^2 thickness was considered. From the earlier studies,[5] it was estimated that the aluminum spherical shielding of 4 g/cm^2 protecting the human and applied to the triple events of July 1959 solar activity allowed less than 10% chance of inducing any symptoms from radiation.

Note:

Requests for further information may be directed to:
Technology Utilization Officer
NASA Headquarters
Code KT
Washington, D.C. 20546
Reference: TSP72-10662

(continued overleaf)

References:

1. S. B. Curtis and M. C. Wilkinson, "Study of Radiation Hazards to Man on Extended Missions," NASA CR-1037, May 1968.
2. S. B. Curtis, W. R. Doherty, and M. C. Wilkinson, "Study of Radiation Hazards to Man on Extended Near Earth Missions," NASA CR-1469, December 1970.
3. W. R. Webber, "An Evaluation of Solar-Cosmic Ray Events During Solar Minimum," Boeing Document D2-90469, December 1963.
4. W. R. Webber, "An Evaluation of Solar-Cosmic Ray Events During Solar Minimum," Boeing Document D2-84274-1, June 1966.
5. W. H. Lagham, *Radiological Factors in Manned Space Flight,* National Academy of Sciences, 1967, Washington, D.C.

Patent status:

NASA has decided not to apply for a patent.

Source: S. B. Curtis and M. C. Wilkinson of
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